

US008160683B2

(12) **United States Patent**  
**Shah et al.**

(10) **Patent No.:** **US 8,160,683 B2**  
(45) **Date of Patent:** **Apr. 17, 2012**

(54) **SYSTEM AND METHOD FOR INTEGRATING VOICE WITH A MEDICAL DEVICE**

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(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

4,700,708 A	10/1987	New, Jr. et al.
4,714,341 A	12/1987	Hamaguri et al.
4,770,179 A	9/1988	New, Jr. et al.
4,805,623 A	2/1989	Jobsis
4,869,254 A	9/1989	Stone et al.
4,911,167 A	3/1990	Corenman et al.
4,936,679 A	6/1990	Mersch
4,972,331 A	11/1990	Chance
5,078,163 A	1/1992	Stone et al.
5,119,815 A	6/1992	Chance
5,122,974 A	6/1992	Chance
5,167,230 A	12/1992	Chance
5,267,174 A	11/1993	Kaufman et al.
5,297,548 A	3/1994	Pologe

(Continued)

(21) Appl. No.: **12/981,974**

(22) Filed: **Dec. 30, 2010**

(65) **Prior Publication Data**

US 2011/0098544 A1 Apr. 28, 2011

**Related U.S. Application Data**

(63) Continuation of application No. 11/540,457, filed on Sep. 29, 2006, now abandoned.

(51) **Int. Cl.**  
**A61B 5/00** (2006.01)

(52) **U.S. Cl.** ..... **600/509**; 600/481; 600/300; 704/275

(58) **Field of Classification Search** ..... 600/300, 600/301, 513, 509, 508, 523, 483, 532; 128/903, 128/904, 920; 340/573.1, 539.11; 725/116; 705/3, 2; 700/242; 704/270, 275

See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

3,638,640 A	2/1972	Shaw
4,621,643 A	11/1986	New, Jr. et al.
4,653,498 A	3/1987	New, Jr. et al.

**FOREIGN PATENT DOCUMENTS**

DE 10213692 A1 10/2003

(Continued)

**OTHER PUBLICATIONS**

Lee, Jason C.S., et al., "Measurement of Percent Carboxyhemoglobin with Pulse-Oximetry Technique," *IEEE Engineering in Medicine & Biology Society 10<sup>th</sup> Annual International Conference*, CH2566-88, vol. 88, pp. 1781-1782 (1988).

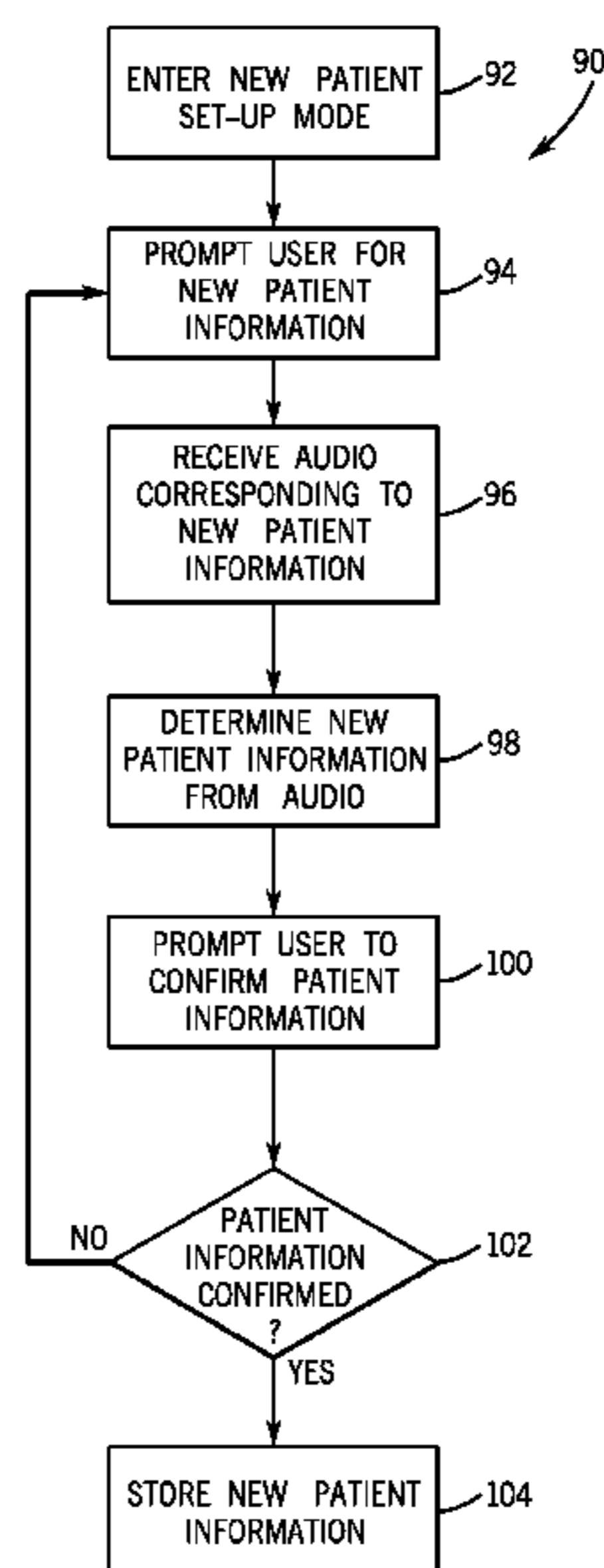
(Continued)

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(57) **ABSTRACT**

There is provided a system and method for integrating voice with a medical device. More specifically, in one embodiment, there is provided a medical device comprising a speech recognition system configured to receive a processed voice, compare the processed voice to a speech database, identify a command for the medical device corresponding to the processed voice based on the comparison, and execute the identified medical device command.

**26 Claims, 7 Drawing Sheets**



U.S. PATENT DOCUMENTS					
			7,136,684 B2	11/2006	Matsuura et al.
5,329,459 A	7/1994	Kaufman et al.	7,186,966 B2	3/2007	Al-Ali
5,348,008 A	9/1994	Bornn et al.	7,209,775 B2	4/2007	Bae et al.
5,351,685 A	10/1994	Potratz	7,306,560 B2	12/2007	Illiff
5,355,880 A	10/1994	Thomas et al.	7,539,532 B2	5/2009	Tran
5,368,026 A	11/1994	Swedlow et al.	7,539,533 B2*	5/2009	Tran ..... 600/509
5,372,136 A	12/1994	Steuer et al.	7,698,002 B2	4/2010	Music et al.
5,385,143 A	1/1995	Aoyagi	7,706,896 B2	4/2010	Music et al.
5,482,036 A	1/1996	Diab et al.	2001/0005773 A1	6/2001	Larsen et al.
5,533,507 A	7/1996	Potratz	2001/0020122 A1	9/2001	Steuer et al.
5,553,614 A	9/1996	Chance	2001/0039376 A1	11/2001	Steuer et al.
5,564,417 A	10/1996	Chance	2001/0044700 A1	11/2001	Kobayashi et al.
5,572,241 A	11/1996	Kanayama et al.	2002/0026106 A1	2/2002	Khalil et al.
5,575,285 A	11/1996	Takanashi et al.	2002/0035318 A1	3/2002	Mannheimer et al.
5,594,638 A	1/1997	Illiff	2002/0038079 A1	3/2002	Steuer et al.
5,630,413 A	5/1997	Thomas et al.	2002/0038081 A1	3/2002	Fein et al.
5,645,059 A	7/1997	Fein et al.	2002/0042558 A1	4/2002	Mendelson
5,645,060 A	7/1997	Yorkey	2002/0049389 A1	4/2002	Abreu
5,662,106 A	9/1997	Swedlow et al.	2002/0062071 A1	5/2002	Diab et al.
5,692,503 A	12/1997	Kuenstner	2002/0111748 A1	8/2002	Kobayashi et al.
5,754,111 A	5/1998	Garcia	2002/0133068 A1	9/2002	Huiku
5,758,644 A	6/1998	Diab et al.	2002/0161287 A1	10/2002	Schmitt
5,779,631 A	7/1998	Chance	2002/0161290 A1	10/2002	Chance
5,806,515 A	9/1998	Bare et al.	2002/0165439 A1	11/2002	Schmitt
5,830,139 A	11/1998	Abreu	2002/0173721 A1	11/2002	Grunwald et al.
5,842,981 A	12/1998	Larsen et al.	2002/0198443 A1	12/2002	Ting
5,873,821 A	2/1999	Chance et al.	2003/0023140 A1	1/2003	Chance
5,995,856 A	11/1999	Mannheimer et al.	2003/0055324 A1	3/2003	Wasserman
6,011,986 A	1/2000	Diab et al.	2003/0060693 A1	3/2003	Monfre et al.
6,035,223 A	3/2000	Baker	2003/0093503 A1	5/2003	Yamaki et al.
6,064,898 A	5/2000	Aldrich	2003/0130016 A1	7/2003	Matsuura et al.
6,120,460 A	9/2000	Abreu	2003/0135095 A1	7/2003	Illiff
6,134,460 A	10/2000	Chance	2003/0139687 A1	7/2003	Abreu
6,163,715 A	12/2000	Larsen et al.	2003/0144584 A1	7/2003	Mendelson
6,181,958 B1	1/2001	Steuer et al.	2003/0195402 A1	10/2003	Fein et al.
6,230,035 B1	5/2001	Aoyagi et al.	2003/0220548 A1	11/2003	Schmitt
6,266,546 B1	7/2001	Steuer et al.	2003/0220576 A1	11/2003	Diab
6,312,393 B1	11/2001	Abreu	2004/0006261 A1	1/2004	Swedlow et al.
6,397,091 B2	5/2002	Diab et al.	2004/0010188 A1	1/2004	Wasserman
6,415,236 B2	7/2002	Kobayashi et al.	2004/0054270 A1	3/2004	Pewzner et al.
6,438,399 B1	8/2002	Kurth	2004/0087846 A1	5/2004	Wasserman
6,445,597 B1	9/2002	Boylan et al.	2004/0107065 A1	6/2004	Al-Ali
6,478,800 B1	11/2002	Fraser et al.	2004/0127779 A1	7/2004	Steuer et al.
6,487,439 B1	11/2002	Skladnev et al.	2004/0162472 A1	8/2004	Berson et al.
6,501,974 B2	12/2002	Huiku	2004/0171920 A1	9/2004	Mannheimer et al.
6,501,975 B2	12/2002	Diab et al.	2004/0176670 A1	9/2004	Takamura et al.
6,526,301 B2	2/2003	Larsen et al.	2004/0176671 A1	9/2004	Fine et al.
6,544,193 B2	4/2003	Abreu	2004/0204635 A1	10/2004	Scharf et al.
6,546,267 B1	4/2003	Sugiura et al.	2004/0215958 A1	10/2004	Ellis et al.
6,549,795 B1	4/2003	Chance	2004/0230106 A1	11/2004	Schmitt et al.
6,591,122 B2	7/2003	Schmitt	2005/0033580 A1	2/2005	Wang et al.
6,594,513 B1	7/2003	Jobsis et al.	2005/0080323 A1	4/2005	Kato
6,606,509 B2	8/2003	Schmitt	2005/0101850 A1	5/2005	Parker
6,615,064 B1	9/2003	Aldrich	2005/0107676 A1	5/2005	Acosta et al.
6,622,095 B2	9/2003	Kobayashi et al.	2005/0113656 A1	5/2005	Chance
6,658,277 B2	12/2003	Wasserman	2005/0168722 A1	8/2005	Forstner et al.
6,662,030 B2	12/2003	Khalil et al.	2005/0192488 A1	9/2005	Bryenton et al.
6,671,526 B1	12/2003	Aoyagi et al.	2005/0203357 A1	9/2005	Debreczeny et al.
6,671,528 B2	12/2003	Steuer et al.	2005/0267346 A1	12/2005	Faber et al.
6,678,543 B2	1/2004	Diab et al.	2005/0280531 A1	12/2005	Fadem et al.
6,690,958 B1	2/2004	Walker et al.	2006/0009688 A1	1/2006	Lamego et al.
6,693,812 B1	2/2004	Li et al.	2006/0015021 A1	1/2006	Cheng
6,708,048 B1	3/2004	Chance	2006/0020181 A1	1/2006	Schmitt
6,711,424 B1	3/2004	Fine et al.	2006/0025660 A1	2/2006	Swedlow et al.
6,711,425 B1	3/2004	Reuss	2006/0030762 A1	2/2006	David et al.
6,748,254 B2	6/2004	O'Neil et al.	2006/0030763 A1	2/2006	Mannheimer et al.
6,785,568 B2	8/2004	Chance	2006/0030765 A1	2/2006	Swedlow et al.
6,801,797 B2	10/2004	Mannheimer et al.	2006/0052680 A1	3/2006	Diab
6,801,799 B2	10/2004	Mendelson	2006/0058683 A1	3/2006	Chance
6,849,045 B2	2/2005	Illiff	2006/0058691 A1	3/2006	Kiani
6,873,865 B2	3/2005	Steuer et al.	2006/0142740 A1	6/2006	Sherman et al.
6,934,571 B2	8/2005	Wiesmann et al.	2006/0195025 A1	8/2006	Ali et al.
6,947,780 B2	9/2005	Scharf	2006/0220881 A1	10/2006	Al-Ali et al.
6,949,081 B1	9/2005	Chance	2006/0226992 A1	10/2006	Al-Ali et al.
6,961,598 B2	11/2005	Diab	2006/0238358 A1	10/2006	Al-Ali et al.
6,996,427 B2	2/2006	Ali et al.	2007/0265533 A1	11/2007	Tran
7,001,334 B2	2/2006	Reed et al.	2007/0270665 A1	11/2007	Yang et al.
7,024,233 B2	4/2006	Ali et al.	2008/0004904 A1	1/2008	Tran
7,027,849 B2	4/2006	Al-Ali	2008/0082338 A1	4/2008	O'Neil et al.

2008/0082339 A1 4/2008 Li et al.  
2008/0097175 A1 4/2008 Boyce et al.  
2008/0097176 A1 4/2008 Music et al.  
2008/0097177 A1 4/2008 Music et al.  
2008/0208009 A1 8/2008 Shklarski  
2008/0242959 A1 10/2008 Xu et al.

FOREIGN PATENT DOCUMENTS

EP 1905356 A1 4/2008  
EP 1986543 A1 11/2008  
JP 5212016 8/1993  
WO WO9220273 11/1992  
WO WO9403102 2/1994  
WO WO9749330 12/1997  
WO WO0145553 A1 6/2001  
WO WO2006006158 A1 1/2006  
WO WO2006009830 A2 1/2006  
WO WO2006039752 A1 4/2006  
WO WO2007017777 A2 2/2007  
WO WO2007097754 A1 8/2007  
WO WO2007140151A21 12/2007

OTHER PUBLICATIONS

Lee, Jason C.S., et al., "Simultaneous Measurement of Percent Carboxyhemoglobin and Functional Oxygen Saturation," *IEEE Engineering in Medicine and Biology Society*, CH2770-6, vol. 89, pp. 1092-1093, 1989.

Bongard, Frederic S., et al., "Continuous Dual Oximetry in Surgical critical care—Indications and Limitations," *Annals of Surgery*, vol. 216, No. 1, pp. 60-68 (1992).

Sherman, Bruce, MD. et al., "Assessment of Dysphagia with the Use of Pulse Oximetry", *Dysphagia* 14:152-156; Copyright Springer-Verlag New York Inc. 1999.

Tsien, Christine L., "TrendFinder: Automated Detection of Alarmable Trends", Massachusetts Institute of Technology, Jun. 2000 (241 pages).

ISR, PCT/US2007/020378, date of mailing Jul. 7, 2008.

\* cited by examiner

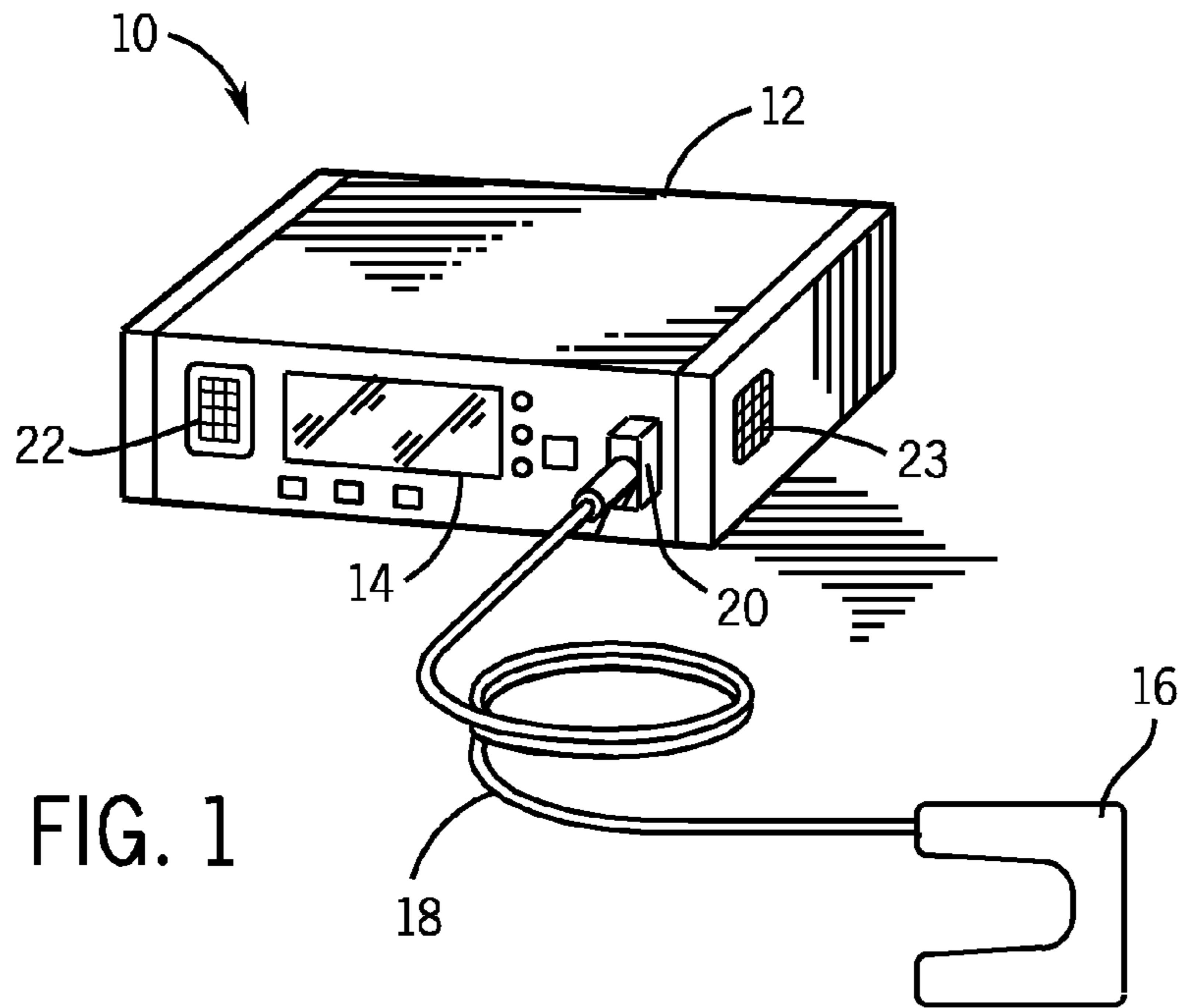


FIG. 1

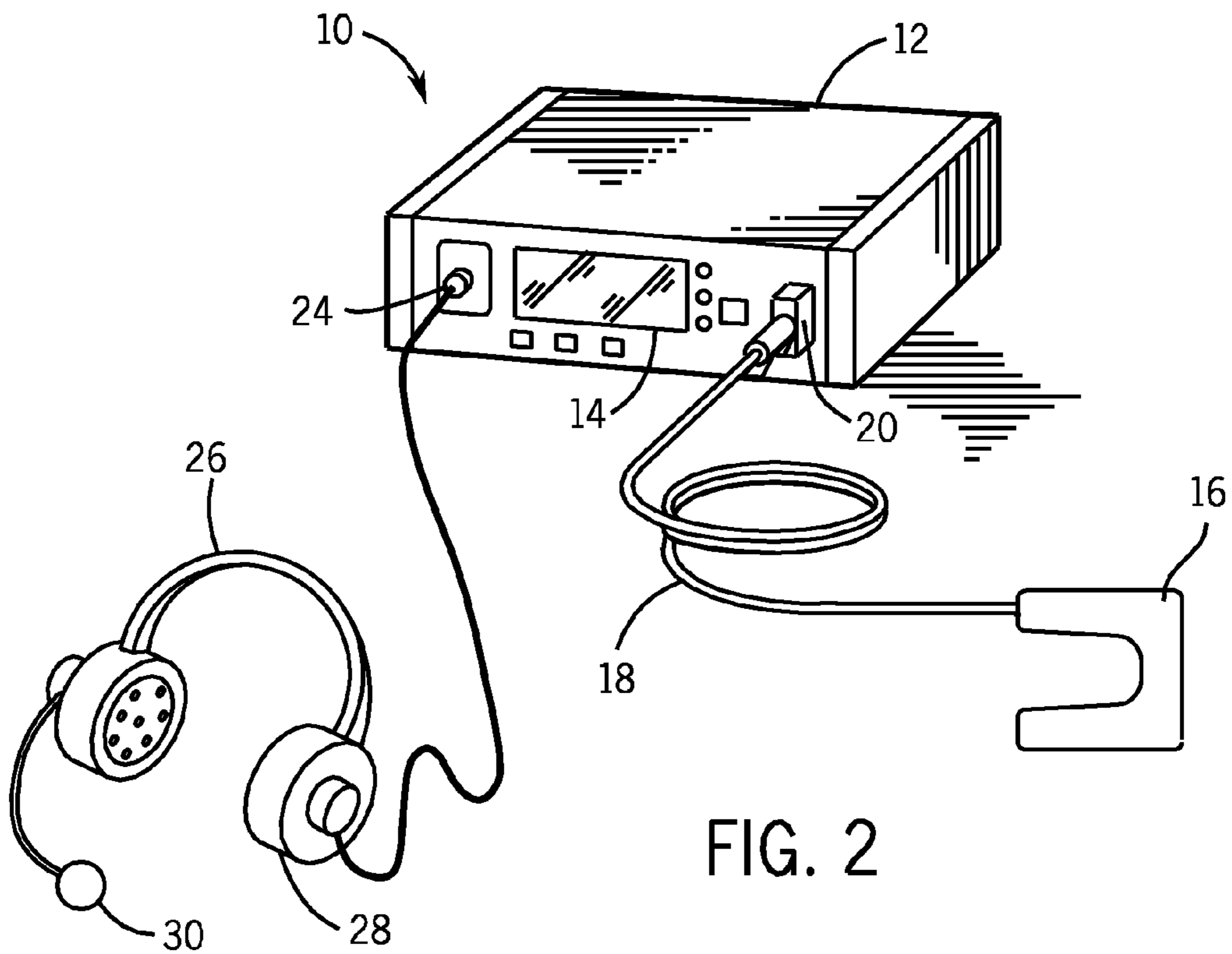


FIG. 2

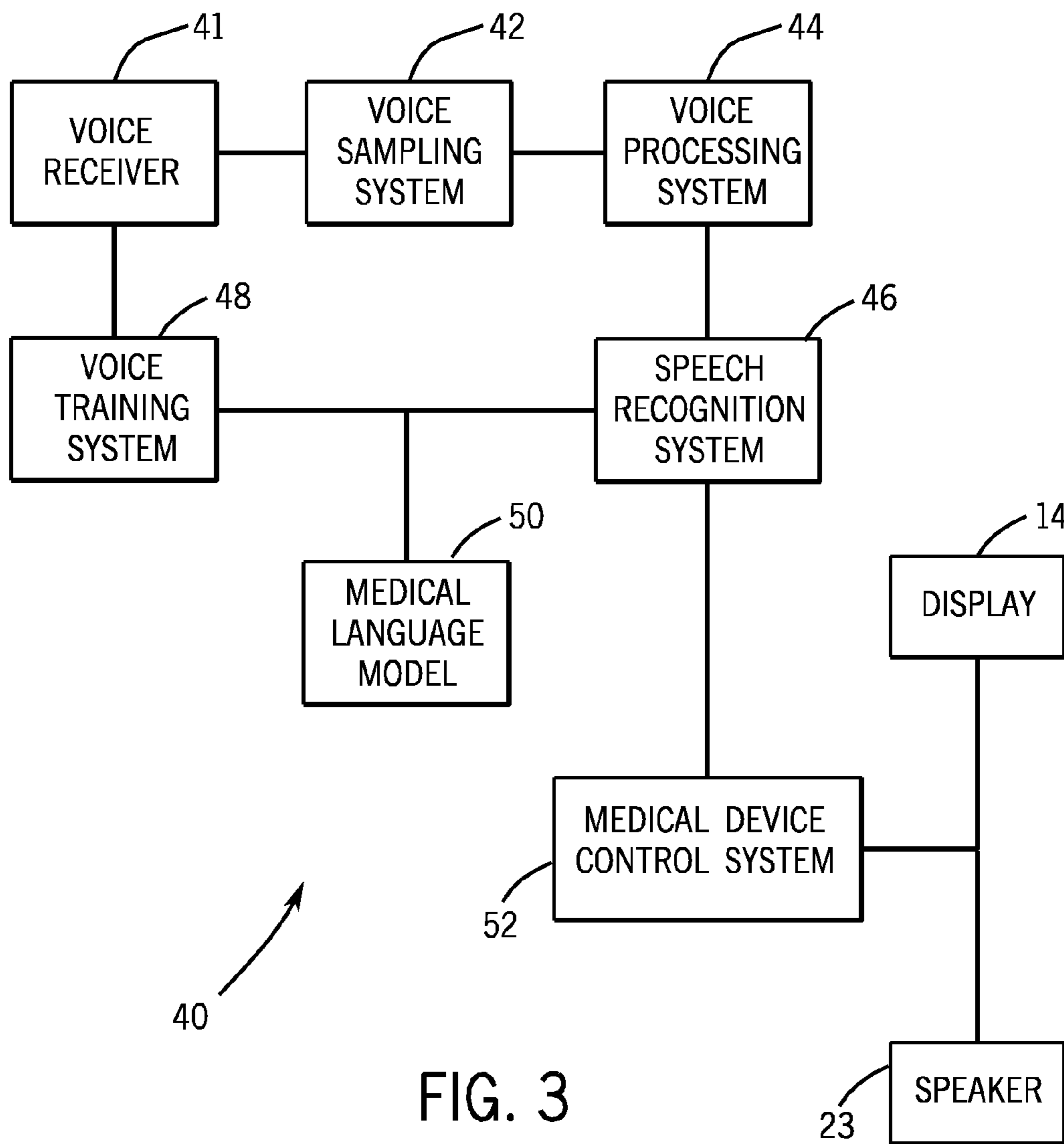


FIG. 3

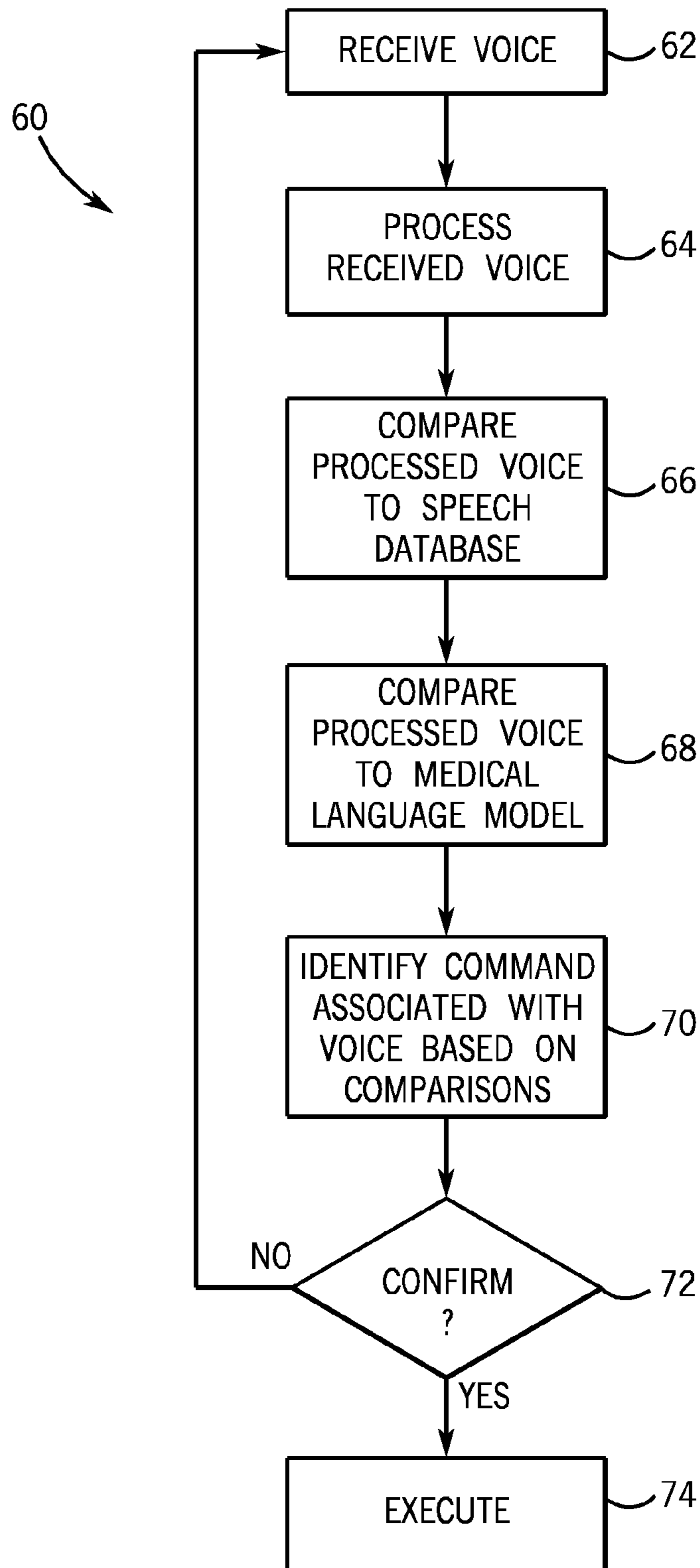


FIG. 4

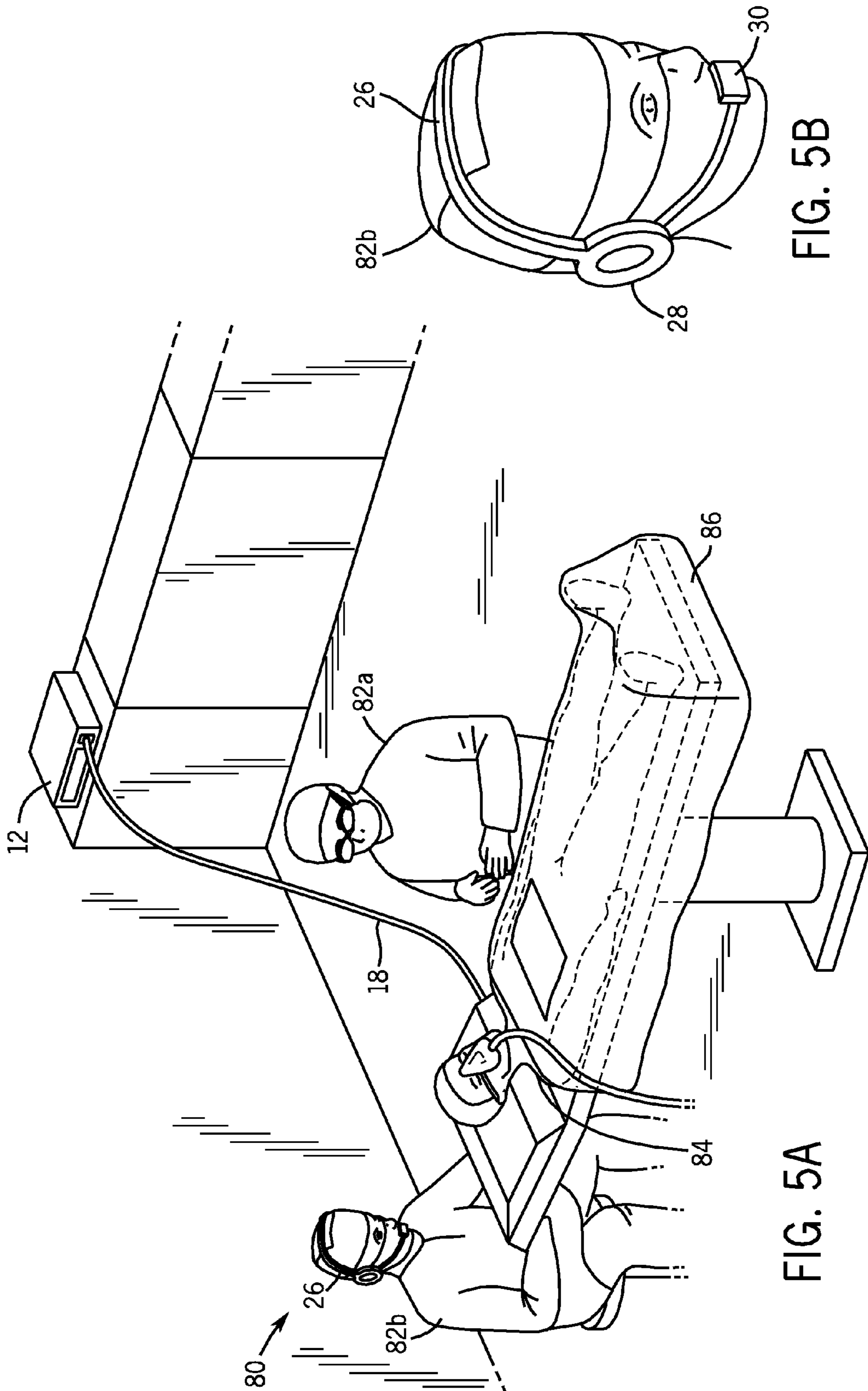


FIG. 5B

FIG. 5A

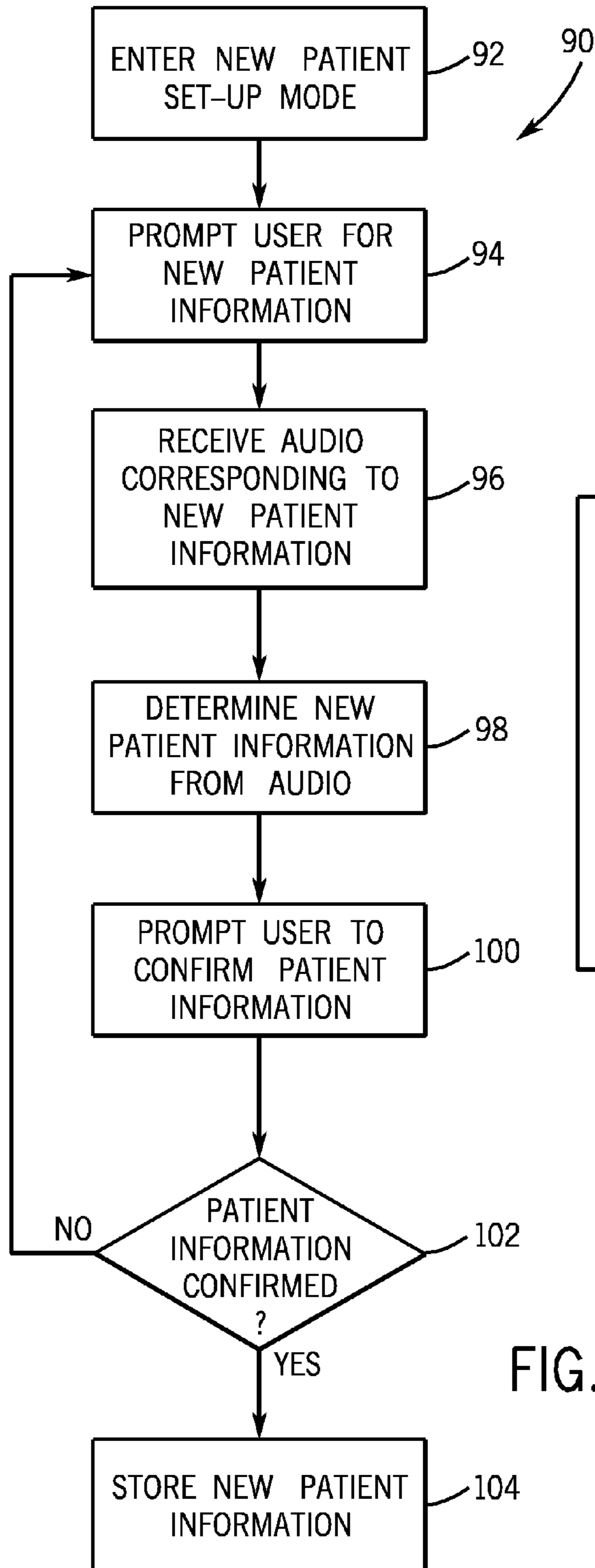


FIG. 6

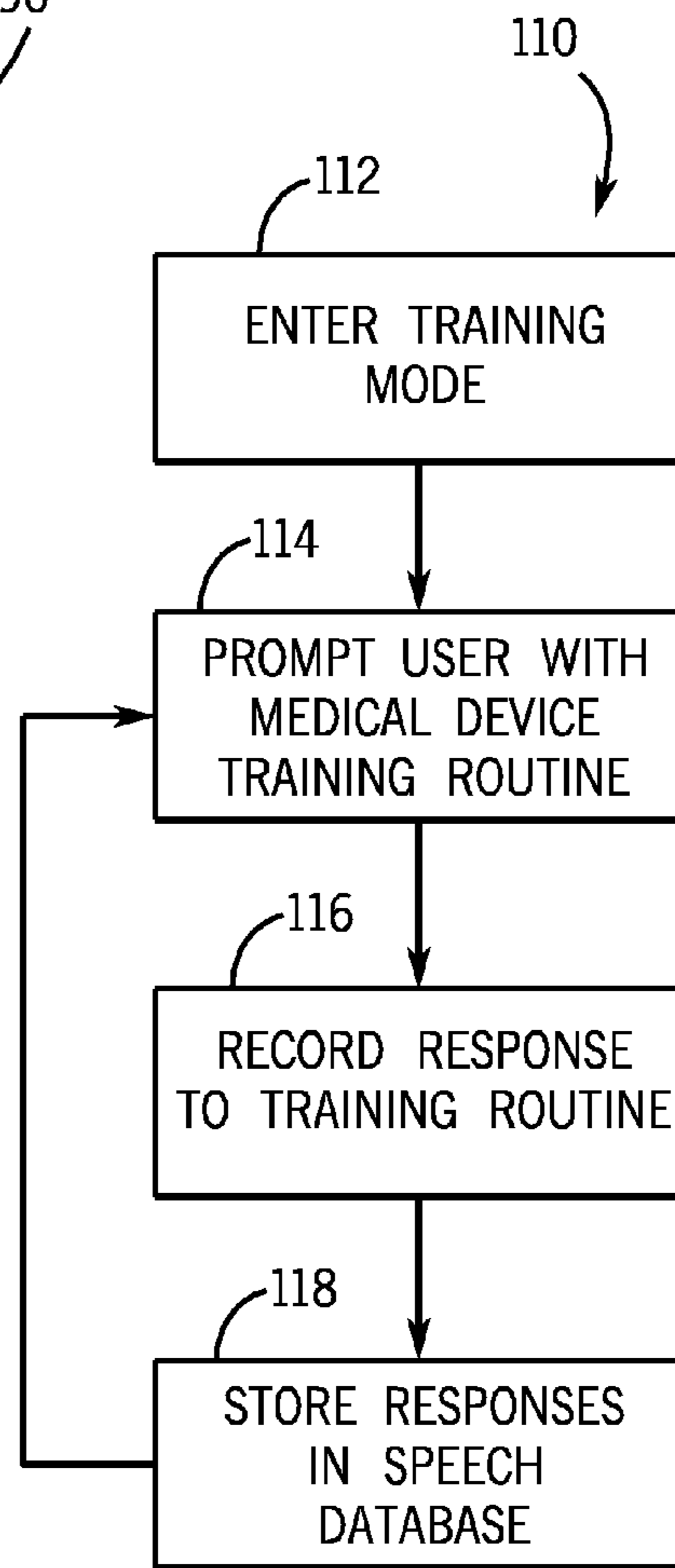


FIG. 7



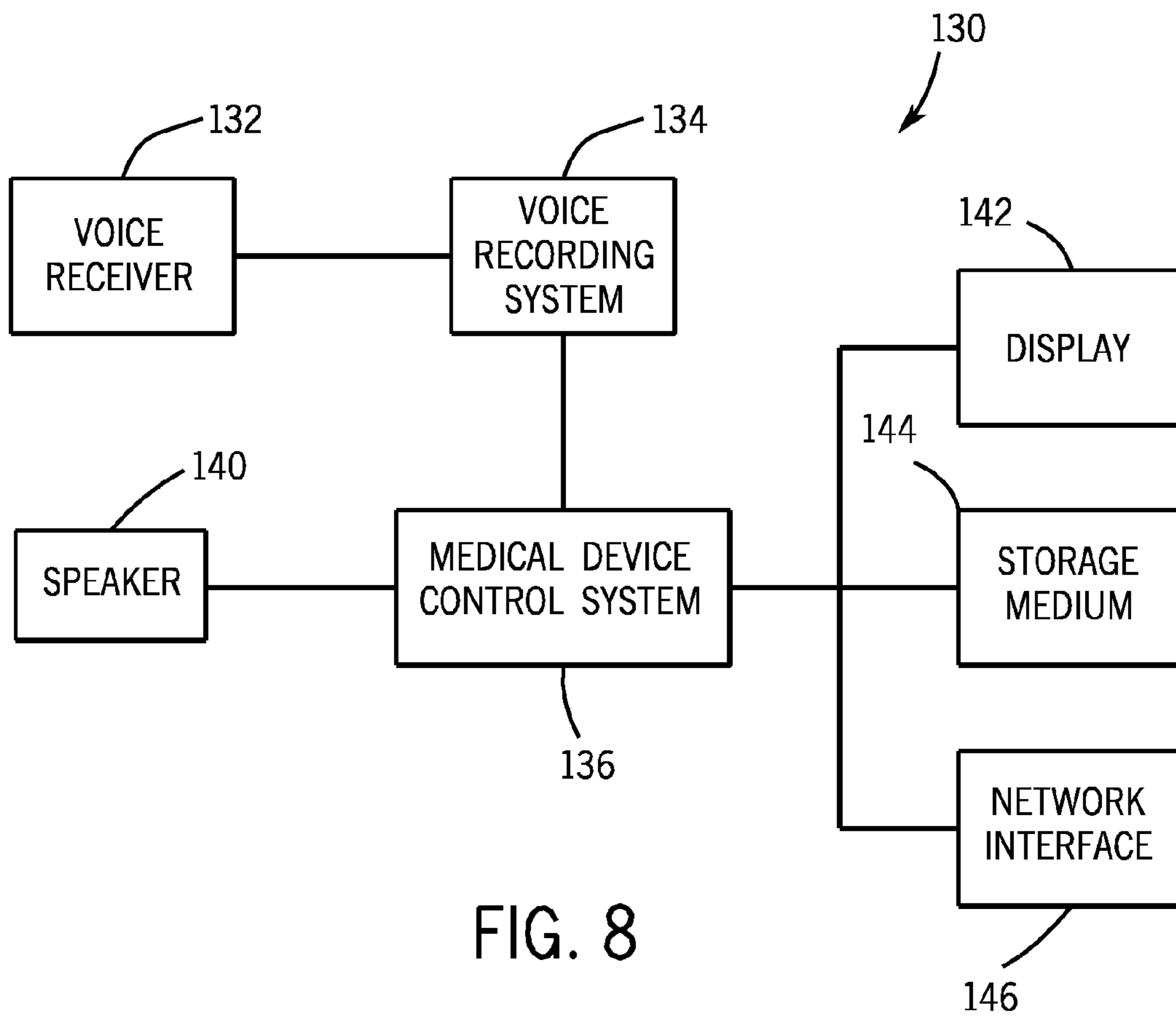


FIG. 8

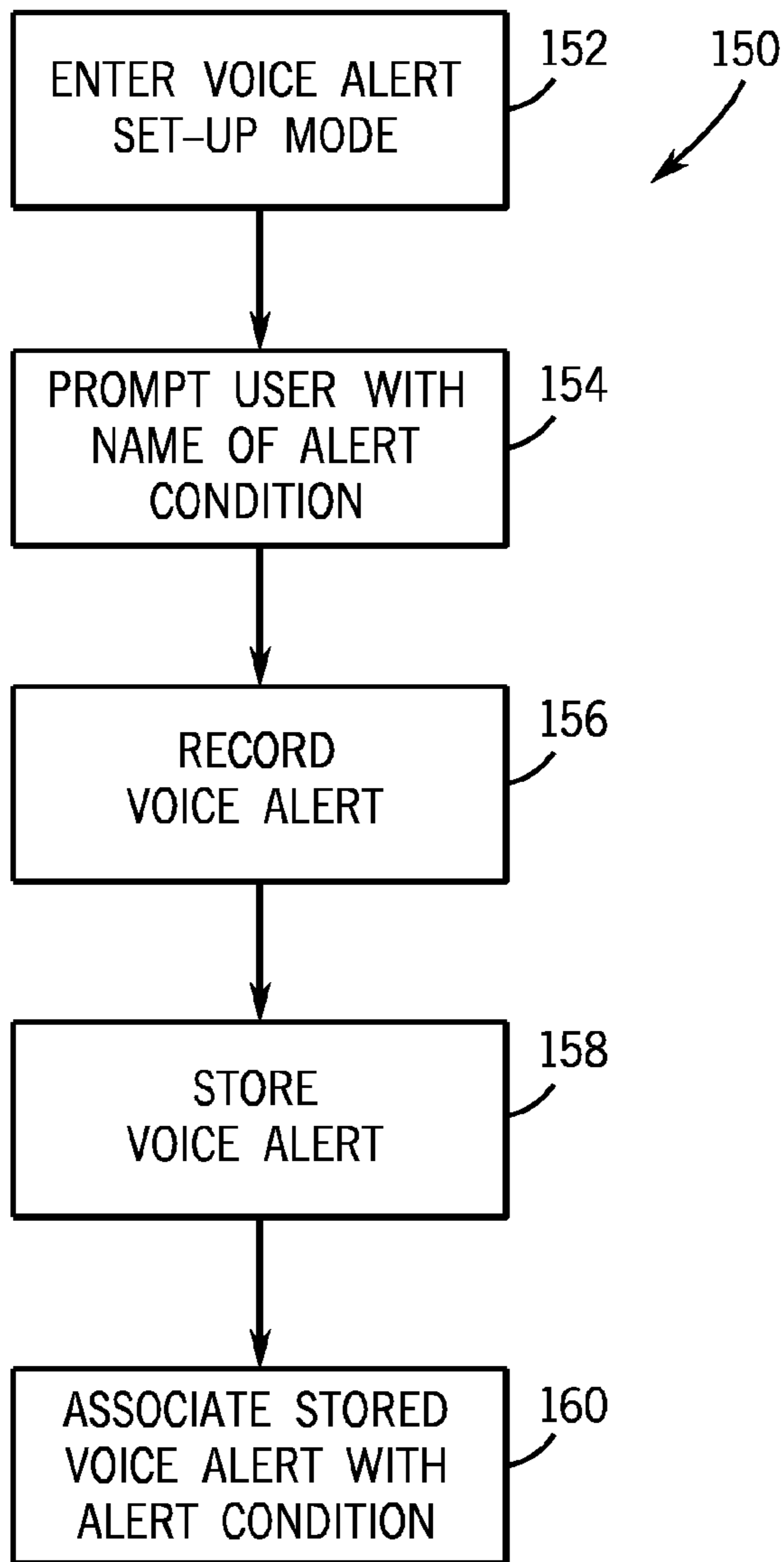


FIG. 9

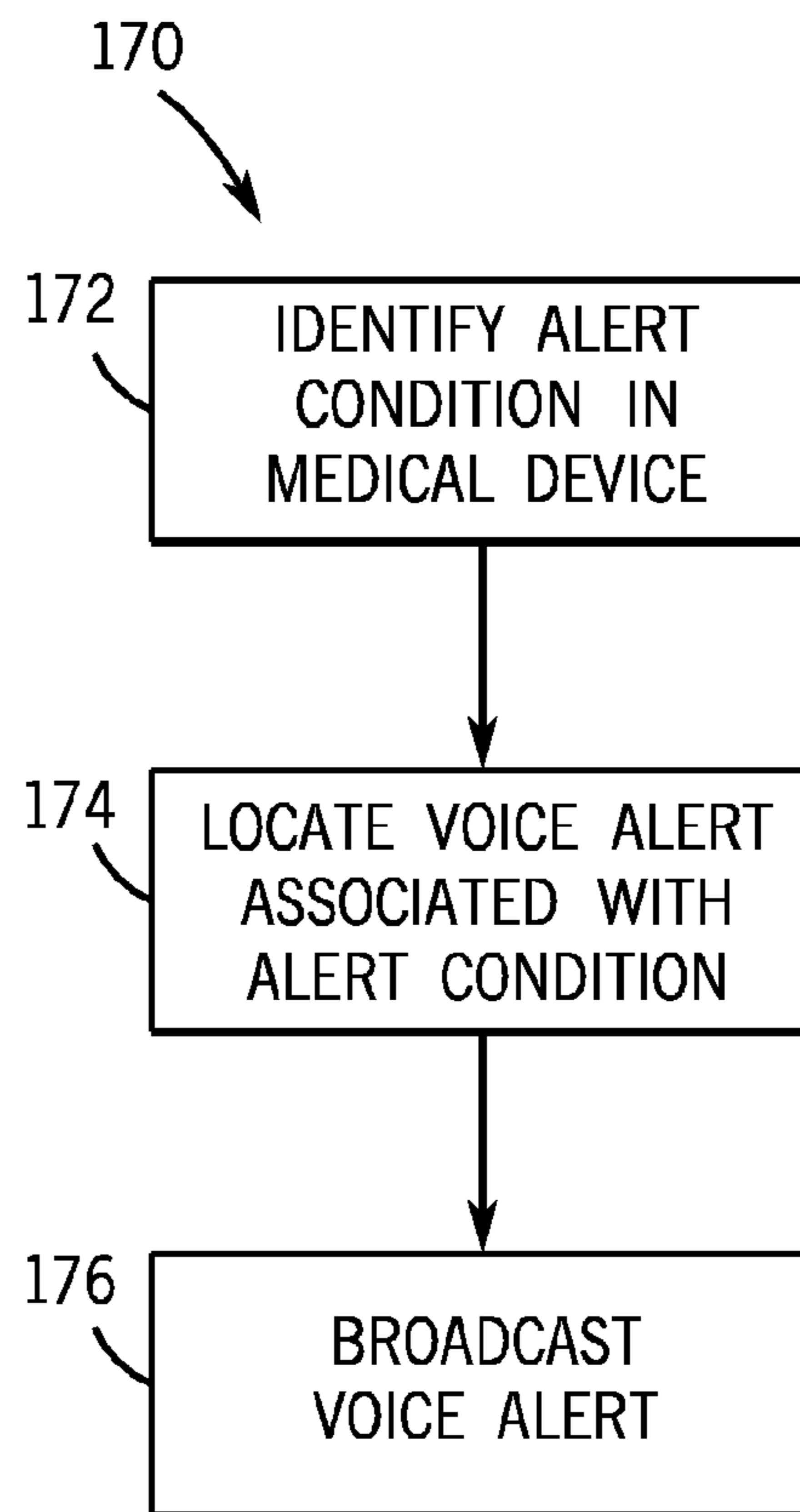


FIG. 10

## 1

**SYSTEM AND METHOD FOR INTEGRATING  
VOICE WITH A MEDICAL DEVICE****CROSS-REFERENCES TO RELATED  
APPLICATION**

This application is a continuation of U.S. patent application Ser. No. 11/540,457 filed on Sep. 29, 2006.

**BACKGROUND OF THE INVENTION**

## 1. Field of the Invention

The present invention relates generally to medical devices and, more particularly, to integrating voice controls and/or voice alerts into the medical device.

## 2. Description of the Related Art

This section is intended to introduce the reader to various aspects of art that may be related to various aspects of the present invention, which are described and/or claimed below. This discussion is believed to be helpful in providing the reader with background information to facilitate a better understanding of the various aspects of the present invention. Accordingly, it should be understood that these statements are to be read in this light, and not as admissions of prior art.

In the field of medicine, doctors often desire to monitor certain physiological characteristics of their patients. Accordingly, a wide variety of devices have been developed for monitoring physiological characteristics. Such devices provide caregivers, such as doctors, nurses, and/or other health-care personnel, with the information they need to provide the best possible healthcare for their patients. As a result, such monitoring devices have become an indispensable part of modern medicine.

For example, one technique for monitoring certain physiological characteristics of a patient is commonly referred to as pulse oximetry, and the devices built based upon pulse oximetry techniques are commonly referred to as pulse oximeters. Pulse oximetry may be used to measure various blood flow characteristics, such as the blood-oxygen saturation of hemoglobin in arterial blood, the volume of individual blood pulsations supplying the tissue, and/or the rate of blood pulsations corresponding to each heartbeat of a patient.

Pulse oximeters and other medical devices are typically mounted on stands that are positioned around a patient's bed or around an operating room table. When a caregiver desires to command the medical device (e.g., program, configure, and so-forth) they manipulate controls or push buttons on the monitoring device itself. The medical device typically provides results or responses to commands on a liquid crystal display ("LCD") screen mounted in an externally visible position within the monitoring device.

This conventional configuration, however, has several disadvantages. First, as described above, this conventional configuration relies upon physical contact with the monitoring device to input commands (e.g., pushing a button, turning a knob, and the like). Such physical contact, however, raises several concerns. Among these concerns are that in making contact with the medical device, the caregiver may spread illness or disease from room to room. More specifically, a caregiver may accidentally deposit germs (e.g., bacteria, viruses, and so forth) on the medical device while manipulating the device's controls. These germs may then be spread to the patient when a subsequent caregiver touches the medical device and then touches the patient. Moreover, if the medical device is moved from one patient room to another, germs transferred to the medical device via touch may be carried from one patient room to another. Even in operating rooms

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where medical devices are typically static, germs may be transferred onto a medical device during one surgery and subsequently transferred off the medical device during a later performed surgery.

Second, beyond contamination, monitoring devices that rely on physical contact for command input may clutter the caregiver's workspace. For example, because the medical device must be within an arm's length of the caregiver, the medical device may crowd the caregiver—potentially even restricting free movement of the caregiver. In addition, caregivers may have difficulty manipulating controls with gloved hands. For example, it may be difficult to grasp a knob or press a small button due to the added encumbrance of a latex glove.

Third, current trends in general medical device design focus on miniaturizing overall medical device size. However, as controls which rely on physical contact must be large enough for most, if not all, caregivers to manipulate with their hands, medical devices that employ these types of controls are limited in their possible miniaturization. For example, even if it were possible to produce a conventional oximeter that was the size of a postage stamp, it would be difficult to control this theoretical postage stamp-sized pulse oximeter with currently available techniques.

In addition, conventional techniques for outputting medical data also have several potential drawbacks. For example, as described above, conventional techniques for displaying outputs rely on LCD screens mounted on the medical device itself. Besides constantly consuming power, these LCD screens must be large enough to be visually accessed by a doctor or nurse. As such, the conventional LCD screens employed in typical medical devices also may be a barrier towards miniaturization of the medical device. Further, conventional screen-based output techniques may be impersonal to the patient and may lack configurability by the caregiver.

For at least the reasons set forth above, an improved system or method for interacting with a medical monitoring device would be desirable.

**BRIEF DESCRIPTION OF THE DRAWINGS**

Advantages of the invention may become apparent upon reading the following detailed description and upon reference to the drawings in which:

FIG. 1 is a diagrammatical representation of a pulse oximeter featuring an integral microphone in accordance with one embodiment of the present invention;

FIG. 2 is a diagrammatical representation of a pulse oximeter featuring an external microphone in accordance with one embodiment of the present invention;

FIG. 3 is a block diagram of a medical device configured for voice control in accordance with one embodiment of the present invention;

FIG. 4 is a flow chart illustrating an exemplary technique for processing a voice command in accordance with one embodiment of the present invention;

FIG. 5A illustrates an exemplary operating room employing a medical device configured for voice control in accordance with one embodiment of the present invention;

FIG. 5B illustrates an enlarged view of a caregiver employing a medical device configured for voice control in accordance with one embodiment of the present invention;

FIG. 6 is a flow chart illustrating an exemplary technique for setting up a patient record in a medical device in accordance with one embodiment of the present invention;

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FIG. 7 is a flow chart illustrating an exemplary technique for training a voice system in a medical device in accordance with one embodiment of the present invention;

FIG. 8 is a block diagram of a medical device configured to broadcast voice alerts in accordance with one embodiment of the present invention;

FIG. 9 is a flow chart illustrating an exemplary technique for setting up a voice alert in accordance with one embodiment of the present invention; and

FIG. 10 is a block diagram illustrating an exemplary technique for broadcasting a voice alert in accordance with one embodiment of the present invention.

### DETAILED DESCRIPTION OF SPECIFIC EMBODIMENTS

One or more specific embodiments of the present invention will be described below. In an effort to provide a concise description of these embodiments, not all features of an actual implementation are described in the specification. It should be appreciated that in the development of any such actual implementation, as in any engineering or design project, numerous implementation-specific decisions must be made to achieve the developers' specific goals, such as compliance with system-related and business-related constraints, which may vary from one implementation to another. Moreover, it should be appreciated that such a development effort might be complex and time consuming, but would nevertheless be a routine undertaking of design, fabrication, and manufacture for those of ordinary skill having the benefit of this disclosure.

Turning initially to FIG. 1, an exemplary pulse oximeter featuring an integral microphone in accordance with one embodiment is illustrated and generally designated by the reference numeral 10. The pulse oximeter 10 may include a main unit 12 that houses hardware and/or software configured to calculate various physiological parameters. As illustrated, the main unit 12 may include a display 14 for displaying the calculated physiological parameters, such as oxygen saturation or pulse rate, to a caregiver or patient. In alternate embodiments, as described in further detail below, the display 14 may be omitted from the main unit 12.

The pulse oximeter 10 may also include a sensor 16 that may be connected to a body part (e.g., finger, forehead, toe, or earlobe) of a patient or a user. The sensor 16 may be configured to emit signals or waves into the patient's or user's tissue and detect these signals or waves after dispersion and/or reflection by the tissue. For example, the sensor 16 may be configured to emit light from two or more light emitting diodes ("LEDs") into pulsatile tissue (e.g., finger, forehead, toe, or earlobe) and then detect the transmitted light with a light detector (e.g., a photodiode or photo-detector) after the light has passed through the pulsatile tissue.

As those of ordinary skill in the art will appreciate, the amount of transmitted light that passes through the tissue generally varies in accordance with a changing amount of blood constituent in the tissue and the related light absorption. On a beat-by-beat basis, the heart pumps an incremental amount of arterial blood into the pulsatile tissue, which then drains back through the venous system. The amount of light that passes through the blood-perfused tissue varies with the cardiac-induced cycling arterial blood volume. For example, when the cardiac cycle causes more light-absorbing blood to be present in the tissue, less light travels through the tissue to strike the sensor's photo-detector. These pulsatile signals allow the pulse oximeter 10 to measure signal continuation

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caused by the tissue's arterial blood, because light absorption from other tissues remains generally unchanged in the relevant time span.

In alternate embodiments, the sensor 16 may take other suitable forms beside the form illustrated in FIG. 1. For example, the sensor 16 may be configured to be clipped onto a finger or earlobe or may be configured to be secured with tape or another static mounting technique. The sensor 16 may be connected to the main unit 12 via a cable 18 and a connector 20.

The pulse oximeter 10 may also include an integral microphone 22. As will be described further below, the integral microphone 22 may be configured to receive voice commands from a caregiver or user that can be processed into commands for the pulse oximeter 10. Although FIG. 1 illustrates the integral microphone 22 as being located on a front façade of the main unit 12, it will be appreciated that in alternate embodiments, the integral microphone 22 may be located at another suitable location on or within the main unit 12.

The pulse oximeter 10 may also include a speaker 23. As will be described further below, the speaker 23 may be configured to broadcast voice alerts or other suitable types of alerts to a caregiver or user. Although FIG. 1 illustrates the speaker 23 as being located on a side façade of the main unit 12, it will be appreciated that in alternate embodiments, the speaker 23 may be located at another suitable location on or within the main unit 12.

Turning next to FIG. 2, another embodiment of the exemplary pulse oximeter 10 featuring an external microphone and speaker in accordance with one embodiment is illustrated. For simplicity, like reference numerals have been used to designate those features previously described in regard to FIG. 1. As illustrated, the pulse oximeter 10 of FIG. 2 also includes the main unit 12, the screen 14, the sensor 16, the cable 18, and the connector 20. However, in place of or in addition to the integral microphone 22, the pulse oximeter 10 illustrated in FIG. 2 may also include an audio connector 24 suitable for coupling a headset 26 to the main unit 12.

As illustrated in FIG. 2, the headset 26 may include one or more speakers 28 and an external microphone 30. As will be described further below, the one or more external speakers 28 may be employed by the pulse oximeter 10 to broadcast voice alerts or other suitable alerts to a caregiver or user. In addition, the external microphone 30 may be employed to receive voice commands for the pulse oximeter 10, as described further below.

FIG. 3 is a block diagram of an exemplary medical device 40 configured for voice control in accordance with one embodiment. For simplicity, like reference numerals have been used to designate those features previously described with regard to FIGS. 1 and 2. In one embodiment, the pulse oximeter 10 set forth in FIGS. 1 and/or 2 may comprise the medical device 40. As illustrated in FIG. 3, the medical device 40 may include a plurality of modules (blocks 41-52). These modules may be hardware, software, or some combination of hardware and software. Additionally, it will be appreciated that the modules shown in FIG. 3 are merely one exemplary embodiment and other embodiments can be envisaged wherein the module functions are split up differently or wherein some modules are not included or other modules are included.

As illustrated in FIG. 3, the medical device 40 may include a voice receiver 41. The voice receiver 41 may include any suitable form of microphone or voice recording device, such as the integral microphone 22 (as illustrated in FIG. 1) or the external microphone 30 (as illustrated in FIG. 2). As those of

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ordinary skill in the art will appreciate, the voice receiver **41** may be configured to receive a voice (i.e., an acoustic wave) and to convert the voice into an electronic analog waveform.

The voice receiver **41** may be configured to transmit the analog waveform to a voice sampling system **42**. The voice sampling system **42** may be configured to sample the analog waveform to create digital voice data. For example, in one embodiment, the voice sampling system **42** may be configured to sample the electronic analog waveform 16,000 times per second to create a digital waveform of pulse amplitudes. In alternate embodiments, other suitable sampling techniques may be employed.

The voice processing system **44** may be configured to receive the digital waveform from the voice sampling system **42** and to convert the digital waveform into frequencies that can be recognized by a speech recognition system **46**. In one embodiment, the voice processing system **44** may be configured to perform a fast fourier transform on the incoming digital waveform to generate a plurality of frequencies. The voice processing system **44** may then transmit the plurality of frequencies to the speech recognition system **46**.

The speech recognition system **46** may be pre-populated or programmed with a plurality of frequency combinations that are associated with commands for the medical device **40**. For example, frequencies combinations associated with the voice command “turn off alarm” may be associated with a command for the medical device **40** to silence an alarm. As mentioned above, in one embodiment, the particular frequency combinations may be pre-programmed or pre-configured. However, in alternate embodiments, the frequency combinations may be programmed into the speech database via a voice training system **48**, which will be described in greater detail below.

In addition, the speech recognition system **46** may also be coupled to a medical language model **50**. The medical language model **50** may be programmed with a plurality of command combinations that are prevalently used in controlling the medical device **40**. For example, if the medical device **40** were an oximeter, such as the pulse oximeter **10**, the medical language model **50** may store command combinations such as “turn oximeter off,” “turn alarm off,” “adjust volume,” “pause alarms,” and so-forth. In this way, the medical language model **50** may assist the speech recognition system **46** in determining the medical command associated with a particular voice command.

More specifically, in one embodiment, the medical language model **50** may assist the speech recognition system **46** in determining the proper medical command when the speech recognition system **46** is able to recognize some portion but not all of a voice command. For example, if the speech recognition system **46** is able to recognize the first and third words of the medical command “turn off alarms,” but is unable to recognize the second word, the speech recognition system **46** may search the medical language model **50** for command combinations matching the recognized terms (i.e., “turn” and “alarms”). Because the medical language model **50** may be programmed with only those commands relevant to the operation of the medical device **40**, the medical language model **50** enables the successful recognition of medical commands that would otherwise be unrecognizable by conventional, generic voice recognition systems. The medical language model **50** may be preprogrammed, may be programmed through the voice training system **48**, or may be programmed via an external computer (not shown).

Upon recognizing a voice command as a command for the medical device **40**, the speech recognition system **44** may be configured to transmit the command to a pulse medical device

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system **52**. As will be appreciated by those with ordinary skill in the art, the medical device control system **52** may be configured to control the medical device. For example, if the medical device **40** were the pulse oximeter **10**, the control system **52** would be configured to control the main unit **12** as well as the sensor **16** to produce physiological monitoring results and/or alarms, which may be transmitted to the display **14** or the speaker **23**.

Turning next to FIG. **4**, a flow chart illustrating an exemplary technique for processing a voice command in accordance with one embodiment is illustrated and generally designated by a reference numeral **60**. In one embodiment, the technique **60** may be employed by the medical device **40** (as illustrated in FIG. **3**) or the pulse oximeter **10** (as illustrated in FIGS. **1** and **2**). It will be appreciated, however, that the technique **60** may also be employed by any other suitable type of medical device including, but not limited to, other forms of monitors, respirators, or scanners.

As illustrated by block **62** of FIG. **4**, the technique **60** may begin by receiving a voice (i.e., a portion of spoken audio). For example, in one embodiment, the pulse oximeter **10** may receive the voice via the microphone **23** or the microphone **30**. After receiving the voice, the technique **60** may include processing the received voice, as indicated in block **64**. In one embodiment, processing the received voice may include converting the received voice into one or more frequencies that can be recognized by a speech recognition system, such as the speech recognition system **46** illustrated in FIG. **3**.

The technique **60** may also include comparing the processed voice with a speech database and/or a medical language model, as indicated by blocks **66** and **68**, and as described above with regard to FIG. **3**. For example, in one embodiment, blocks **66** and **68** may include comparing the processed voice to a speech database within the speech recognition system **46** and/or the medical language model **50**.

After performing one or more of these comparisons, the technique **60** may involve identifying a medical device command associated with the processed voice based upon the one or more of the comparisons, as indicated by block **70**. For example, if comparisons to the speech database and/or the medical language model indicate that the processed voice is a command to “turn off alarms,” then technique **60** may involve identifying the medical device command as a command to turn off the medical device’s alarms.

Next, after identifying the medical device command, the technique **60** may include prompting a user (e.g., the caregiver) to confirm the new patient information was correctly determined, as indicated by block **72**. For example, in one embodiment, the pulse oximeter **10** may display the identified command on the display **14** and prompt the user to confirm the correctness of the identified command. If the user does not confirm the command (block **72**), the technique **60** may cycle back to block **62** (see above) and re-prompt the user for the new patient information. If, however, the user confirms the command, the technique may execute the command, as indicated by block **74**. For example, in one embodiment, the user may confirm the command by speaking the word “yes” or the word “execute” in response to the displayed command.

As described above, the pulse oximeter **10** and/or the medical device **40** may be employed in a variety of suitable medical procedures and/or environments. For example, FIG. **5A** illustrates an exemplary operating room setting **80** employing the pulse oximeter **10** in accordance with one embodiment. As illustrated in FIG. **5A**, the operating room **80** may include a first caregiver **82a**, a second caregiver **82b**, and a patient **84**. In addition, the operating room **80** may also include an operating table **86** and the pulse oximeter **10**.

As illustrated, the caregiver **82b** may employ and/or interact with the pulse oximeter **10** by wearing the headset **26**. As highlighted in FIG. **5B**, which illustrates an enlarged view of the caregiver **82b**, the caregiver **82b** may place the speaker **28** over his or her ear and place the external microphone **30** over his or her mouth. In this way, the caregiver **82b** may receive alerts and issue commands from and to the main unit **12** via the headset **26**. Advantageously, the functionality enables the main unit **12** to be placed at a remote location in the operating room **80** such that the main unit **12** does not crowd the medical procedure taking place in the operating room **80**. However, those with ordinary skill in the art will appreciate that the embodiment set forth in FIGS. **5A** and **5B** is merely exemplary, and, as such, not intended to be exclusive. Accordingly, in alternate embodiments, the pulse oximeter **10** and/or the medical device **40** may be employed in any one of a number of suitable medical environments.

As described above, the pulse oximeter **10** and/or the medical device **40** may be configured to receive voice commands. Additionally, however, the pulse oximeter **10** and/or the medical device **40** may also be configured to enable entry of patient information by voice. For example, FIG. **6** is a flow chart illustrating an exemplary technique **90** for setting up a patient record in a medical device in accordance with one embodiment. In one embodiment, the technique **90** may be executed by the pulse oximeter **10** and/or the medical device **40**.

As indicated by block **92** of FIG. **6**, the technique **90** may begin by entering a new patient setup mode, as indicated by block **92**. Next, the technique **90** may involve prompting a user for new patient information, as indicated by block **94**. In one embodiment, prompting the user for new patient information may include displaying a message to the user on the display **14** (see FIGS. **1-3**). Alternatively, prompting the user may involve an audio or voice prompt, as described further below, or another suitable form of user notification.

Next, the technique **90** may include receiving audio corresponding to the new patient information, as indicated by block **96**. In one embodiment, audio corresponding to the new patient information may be received over the internal microphone **22** and/or the external microphone **30**. For example, the external microphone **30** may receive patient information, such as patient name, age, and so-forth from the caregiver **82b** wearing the headset **26**. After receiving the audio corresponding to the new patient information, the technique **90** may involve determining the new patient information from the received audio, as indicated by block **98**. In one embodiment, determining the new patient information may include processing the received audio and comparing the received audio to a speech database and/or medical language model, as described above with regard to FIGS. **3** and **4**.

After determining the new patient information from the received audio, the technique **90** may include prompting a user (e.g., the caregiver **82b**) to confirm the new patient information was correctly determined, as indicated by block **100**. For example, in one embodiment, the pulse oximeter **10** may display the determined patient information on the display **14** and prompt the user to confirm the correctness of the determined patient information with a voice command (e.g., "correct," "yes," and so-forth). If the user does not confirm the new patient information (block **102**), the technique **90** may cycle back to block **94** (see above) and re-prompt the user for the new patient information.

Alternatively, if the user does confirm the determined new patient information, the technique **90** may include storing the new patient information, as indicated by block **104**. For example, in one embodiment, storing the new patient infor-

mation may include storing the patient's name, age, and so-forth in a memory located within the pulse oximeter **10** and/or the medical device **40**.

As described above, one or more embodiments described herein is directed towards a medical device configured to receive voice commands. Accordingly, FIG. **7** illustrates a technique **110** that may be employed to train a voice system in a medical device in accordance with one embodiment. In one embodiment, the technique **110** may be employed by the pulse oximeter **10** and/or the medical device **40**. More specifically, in one embodiment, the technique **110** may be executed by the voice training system **48** of FIG. **3**. However, it will be appreciated, that in alternate embodiments, other suitable medical devices may employ the technique **110**.

As illustrated by block **112** of FIG. **7**, the technique **110** may begin by entering a training mode. In one embodiment, the medical device **40** may be configured to enter a training mode in response to a depressed button or a sequence of depressed buttons on the medical device **40**. Alternatively, in other embodiments, the pulse oximeter **10** and/or the medical device **40** may be configured to enter the training mode in response to a voice command and/or other suitable form of command or instruction.

After entering the training mode, the technique **110** may include prompting a user with a medical device training routine, as indicated by block **114**. The medical device training routine may involve displaying one or more medical device specific words, phrases, or commands on the display **14**. For example, the pulse oximeter **10** may be configured to display commands such as "turn off alarms," "turn down volume," "show pleth," or any other suitable voice command or instruction.

After prompting the user, as described above, the technique **110** may include recording a response to the training routine, as indicated by block **116**. For example, the pulse oximeter **10** and/or the medical device **40** may be configured to record the response to the training routine via the external microphone **30**. After recording the response to the training routine, the technique **110** may include storing the response in a speech database, such as the speech database within the speech recognition system **46**. After storing the response in the speech database, the technique **110** may cycle back to block **114** and repeat the training routine with additional words, phrases, or comments. In one embodiment, medical device **40** may be configured to cycle through blocks **114**, **116**, and **118** for each of a predefined group of words and instructions stored within the voice training system **48**.

Turning next to another embodiment, FIG. **8** is a block diagram of a medical device **130** configured to broadcast voice alerts in accordance with one embodiment. As those of ordinary skill in the art will appreciate, conventional medical devices are configured to use buzzes and/or beeps to indicate medical alerts or alarms (hereafter referred to collectively as "alerts"). In addition to disturbing patients and medical practitioners (and possibly breaking a medical professional's concentration), these buzzes and beeps typically provide no other useful information to a listener other than indicating the presence of an alert condition. Advantageously, the medical device **130** illustrated in FIG. **8** is configured to produce custom voice alerts that can advantageously provide detailed information about the alert conditions while at the same time being less jarring and/or abrasive than traditional medical device alerts.

The medical device **130** may include a voice receiver **132**, such as the microphone **22** or the microphone **30** (FIGS. **1-2**). As will be appreciated, the voice receiver **132** may be configured to receive audio patterns that may be employed to

create voice alerts. The medical device **130** may also include a voice recording system **134** that may be configured to receive audio from the voice receiver **132** and to record the received audio.

The voice recording system **134** may be coupled to a medical device control system **136** that may be configured to receive the recorded audio and to store or play it, when appropriate, to produce voice alerts. For example, the medical device control system **136** may be configured to play an appropriate voice alert over a speaker **140**. In addition, the medical device control system **136** may be coupled to a display **142**. As will be appreciated, the display **142** may be configured to display instructions to a user during setup of the voice alerts as well as for other suitable user notifications.

Further, the medical device control system **136** may also be coupled to a storage medium **144**. In one embodiment, the storage medium **144** is configured to store the recorded audio in an indexed format, such as a look-up table, link list, and so-forth, such that a portion of recorded audio may be associated with one or more alert conditions. As such, in this embodiment, the medical device control system **136**, upon detecting an alert condition, may access the stored portion of recorded audio corresponding to the alert condition and then broadcast the portion of audio over the speaker **130**.

As illustrated, the medical device **130** may also include a network interface **146**. The network interface **146** may be configured to enable the medical device control system **136** to communicate with other computers or computerized devices over a network. In this capacity, the network interface **146** may allow the medical device control system **136** to download and/or upload portions of audio for use as voice alerts.

As described above, one or more of the embodiments set forth herein may be directed towards a medical device configured to produce voice alerts. Accordingly, FIG. **8** is a flow chart illustrating an exemplary technique **150** for setting up a voice alert in accordance with one embodiment. As such, in one embodiment, the technique **150** may be executed by the medical device **130**.

As illustrated by block **152** of FIG. **9**, the technique **150** may begin by entering a voice alert setup mode. In various embodiments, entering a voice alert setup mode may be triggered by a voice command to the medical device **130**, by physically manipulating one or more buttons on the medical device **130**, or by another suitable technique. After entering the voice alert setup mode, the technique **150** may include prompting a user with a name of an alert condition. In one embodiment, the medical device **130** may prompt a user with a name of the alert condition by displaying the name of the alert condition on the display **142**.

Next, the technique **150** may include recording a voice alert corresponding to the prompted alert condition. More specifically, in response to the prompt on the display **142**, a user would speak the voice alert, which would subsequently be recorded as part of the technique **150**. After recording the voice alert, technique **150** may include storing the voice alert (block **158**) and associating the stored voice alert with the alert condition (block **160**). For example, in one embodiment, the voice alert may be stored in the storage medium **144** and the medical device control system **136** may be configured to associate the stored voice alert with one or more of its alert conditions.

As described above, medical device **130** may be configured to broadcast voice alerts. Accordingly, FIG. **10** is a flow chart illustrating an exemplary technique **170** for broadcasting a voice alert in accordance with one embodiment. As shown, the technique **170** may begin by identifying an alert condition in the medical device **130**. For example, in one embodiment,

the medical device control system **136** may be configured to identify an alert condition, such as signal or power loss, as indicated by block **172**.

Upon identifying the alert condition, the technique **170** may include locating a voice alert associated with the alert condition. For example, in one embodiment, the medical device control system **136** may locate a voice alert stored in the storage medium **144** that is associated with the alert condition. Lastly, the technique **170** may include broadcasting the voice alert, as indicated by block **176**. For example, in one embodiment, the medical device control system **136** may be configured to broadcast the voice alert over the speaker **140**.

While the invention may be susceptible to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and have been described in detail herein. However, it should be understood that the invention is not intended to be limited to the particular forms disclosed. Rather, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the following appended claims. Indeed, the present techniques may not only be applied to pulse oximeters, but also to other suitable medical devices. For example, the embodiments set forth herein may also be employed in respirators, ventilators, EEGs, medical cutting devices, and so-forth.

What is claimed is:

**1.** A pulse oximeter comprising:

a speech recognition system configured to:

receive a processed voice of a person proximate to the speech recognition system;

compare the processed voice to a speech database;

identify a command for the pulse oximeter corresponding to the processed voice based on the comparison; and  
execute the identified pulse oximeter command without the person physically touching the pulse oximeter.

**2.** The pulse oximeter, as set forth in claim **1**, comprising a tangible machine readable medium comprising a medical language model, wherein the speech recognition system is configured to identify the command based on the medical language model.

**3.** The pulse oximeter, as set forth in claim **2**, wherein the medical language model comprises a plurality of commands for the pulse oximeter.

**4.** The pulse oximeter, as set forth in claim **1**, comprising a voice training system configured to populate the speech database.

**5.** The pulse oximeter, as set forth in claim **1**, comprising a voice processing system configured to process a received voice of the person proximate to the speech recognition system to create the processed voice.

**6.** The pulse oximeter, as set forth in claim **5**, comprising a headset, wherein the voice processing system is configured to receive the received voice from the headset, wherein the headset is proximate to the pulse oximeter.

**7.** The pulse oximeter, as set forth in claim **5**, comprising an integral microphone, wherein the voice processing system is configured to receive the voice of the person proximate to the speech recognition system from the integral microphone.

**8.** A method comprising:

receiving a processed voice of a person proximate to a pulse oximeter;

comparing the processed voice to a speech database disposed in the pulse oximeter;

identifying a command for the pulse oximeter corresponding to the processed voice based on the comparison; and  
executing the identified pulse oximeter command without the person physically touching the pulse oximeter.

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9. The method, as set forth in claim 8, comprising comparing the received processed voice to an oximeter language model.

10. A pulse oximeter comprising:  
a control system configured to:  
identify an alert condition for the pulse oximeter;  
locate a voice alert corresponding to the alert condition;  
and  
broadcast the voice alert over a speaker to a person proximate to the pulse oximeter.

11. The pulse oximeter, as set forth in claim 10, comprising a voice recording system configured to record the voice alert.

12. The pulse oximeter, as set forth in claim 11, comprising a storage medium, wherein the control system is configured to store the recorded voice alert on the storage medium.

13. The pulse oximeter, as set forth in claim 10, comprising a network interface, wherein the control system is configured to download the voice alert over the network interface.

14. A method of broadcasting voice alerts from a pulse oximeter, the method comprising:

prompting a user proximate to the pulse oximeter with a name of a pulse oximeter alert condition;  
recording a voice alert of the user in the pulse oximeter;  
associating the recorded voice alert with the pulse oximeter alert condition; and  
broadcasting the recorded voice alert to a person proximate to the pulse oximeter when the alert condition is detected.

15. The method, as set forth in claim 14, comprising storing the voice alert in a memory disposed in the pulse oximeter.

16. A method for broadcasting a voice alert from a pulse oximeter, the method comprising:

identifying an alert condition for the pulse oximeter;  
locating a voice alert corresponding to the alert condition;  
and  
broadcasting the voice alert over a speaker integral to the pulse oximeter.

17. The method, as set forth in claim 16, wherein locating the voice alert comprises locating a recorded voice alert in a storage medium coupled to the pulse oximeter.

18. The method, as set forth in claim 16, wherein locating the voice alert comprises locating a recorded voice alert on a network via a network interface.

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19. The method, as set forth in claim 16, wherein identifying the alert condition comprises identifying a loss of signal from a sensor placed on a patient proximate to the pulse oximeter.

20. A method for programming a pulse oximeter with patient information, the method comprising:  
prompting a user proximate to the pulse oximeter for new patient information;  
receiving audio corresponding to the new patient information using the pulse oximeter; and  
determining the new patient information from the audio using the pulse oximeter.

21. The method, as set forth in claim 20, comprising:  
prompting the user to confirm the determined new patient information; and

if the user confirms the new patient information, storing the new patient information in the pulse oximeter.

22. A medical device comprising:

one or more controls on the medical device, wherein activation of a respective control by physical touch executes a corresponding medical device command;

a speech recognition system configured to:  
receive a processed voice of a person proximate to the speech recognition system;

compare the processed voice to a speech database;

identify a command for the medical device corresponding to the processed voice based on the comparison; and

execute the identified medical device command without the person physically touching the one or more controls.

23. The medical device, as set forth in claim 22, comprising a tangible machine readable medium comprising a medical language model, wherein the speech recognition system is configured to identify the command based on the medical language model.

24. The medical device, as set forth in claim 23, wherein the medical device comprises a pulse oximeter and the medical language model comprises a plurality of pulse oximeter commands.

25. The medical device, as set forth in claim 23, wherein the medical language model comprises a plurality of commands for the medical device.

26. The medical device, as set forth in claim 22, comprising a voice training system configured to populate the speech database.

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